1 Special Issue on Space-Time Standards

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Measurement standards are an important part of what is known as the Intellectual Infrastructure. In recent years, this has been in a large revolutionary period of two aspects. The first is the problem of standards which are mutually recognized globally. Due to the diffusion of quality management such as ISO 9000 in the 1990's, it became necessary to formulate the traceability of quantities which are closely related to quality to national standards and the traceability of national standards to international standards. From around 1998, an international framework for guaranteeing the equality within an internationally accepted scope for traceability and national standards for each country has been being developed in cooperation with the Bureau International des Poids et Measures and regional measurement organizations around the world. In addition to international mutual recognition finally getting on track in advanced countries in the past few years, in recent years, developing countries have also made much effort in the areas of measurement standards and legal metrology in order to join the framework. The other major revolution is the recent improvement of measurement technology which enables measurements that were previously impossible, and as a result, the conventional definition of a unit is undergoing great change. For example, the unit of mass is now the only unit that is defined by an object, called prototype (prototype of the kilogram). However, a transition to a universal definition based on the Avogadro constant and the atomic mass unit, or on frequency and relativity, is being examined. There is the same movement in regard to the unit of the temperature and the electric current.

Even in terms of time, space and frequency standards which have attained the highest accuracy among all quantities and whose international comparison is easily conducted by using space positioning technology and satellite communications technology, etc., the same situation applies and in some sense, this is the most advanced component of the revolution. In regard to the first aspect, comparisons and international standard structures for international mutual recognition are constantly improving and remote calibration and time distribution for time business are being utilized in Japan. Furthermore, in regard to the second aspect, in place of cesium atomic frequency standards which were reaching their accuracy limit, upon entering this century, optical frequency standards that enable even higher accuracy and much shorter measurement times are being rapidly developed. This optical frequency standard, which is said to theoretically enable 18 digits accuracy, is expected to have the potential to change our current natural awareness of fundamental sciences and if this is put into practice and becomes wide spread, it is expected to be used in various fields such as positioning measurements and optical communications.

This Special Issue puts together the initiatives conducted by the National Institute of Information and Communications Technology (NICT) for space-time standards in this revolutionary period. Chapter **2** discusses its ambitious initiatives and leadership in Asia for the first aspects of the revolution and Chapter **3** explains the second aspect that the activity in NICT is rapidly reaching the top level of the world and the prospects of achieving the top.

In addition, in Chapters **4** and **5**, while space-time measurement technologies that NICT has

been working on for many years are introduced, new ideas for becoming a world leader during this revolutionary period are also incorporated. We would very much appreciate it if the readers could take a look in this Special Issue at the great developments that show our NICT space-time standards group is entering a new revolutionary and fruitful period.

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Atomic Frequency Standards, Space-Time Measurements